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A PALYNOLOGICAL EXAMINATION OF NO. 1 BORE, BIRREGURRA, VICTORIA

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Summary

Three microfloras have been recognized in No. 1 Government Bore, Parish of Birregurra, Victoria, and each has been tentatively related to microfloras of other deposits.

Introduction

Plant remains are generally regarded as less satisfactory determinants of exact geological age than are marine fossils. Many genera have a long time-range and one that may vary from one country to another, as can be shown, for example, by a comparison between the Cretaceous and Tertiary microfloras of New Zealand and Australia. Recently Suggate and Couper (1952) and Couper (1953) have shown that in New Zealand the sporomorph *Dacrydiumites mawsonii* Cookson and pollen grains of *Nothofagus*, which in Australia seem to make their first appearance in Older Tertiary deposits, occur in the Paparoa beds which are believed to be of Lower Cretaceous age. Furthermore, neither the pollen of *Nothofagus* nor that of any other dicotyledonous species has, as yet, been recognized in residues of Australian Late Mesozoic deposits, although they have been looked for carefully in the Styx River Series of Queensland (probably Lower Cretaceous, Walkom 1919), in which dicotyledonous leaves occur, and the Styx and Burrum Coal Measures (de Jersey, 1951). On the other hand assemblages of plant remains, both macroscopic and microscopic, have often proved extremely useful in correlations between more closely situated strata (Thiergart, 1949).

Most of the palynological work on Australian Tertiary deposits has been carried out on isolated samples of individual and often unrelated beds rather than on a continuous vertical section, and has been mainly concerned with the botanical identification of the various pollen and spore types present in them. Core samples from near the Tertiary-Mesozoic junction at Comaum, South Australia, have been analysed and two microfloras identified (Cookson, 1953), but nothing of a similar nature has been recorded from Victoria before.

This position has now been rectified to some extent by an examination of sampels from No. 1 Government Bore Core, Parish of Birregurra, in south-western Victoria, kindly made available by Dr. D. E. Thomas, Chief Geologist, Mines Department of Victoria. This examination shows that definite changes in the pollen and spore content occur at three levels and indicates that some of these are sufficiently significant to provide a basis for comparison with microspore assemblages from other deposits in Victoria.

The portions of the Birregurra Bore studied came from the following levels: 444-515 feet, 760-960 feet, 1006-1020 feet, and 1076-1090 feet respectively. The break in the deeper parts of the bore is partly accounted for by 33 feet of basalt encountered at 1022 feet. The Mesozoic bedrock was struck at 1063 feet.

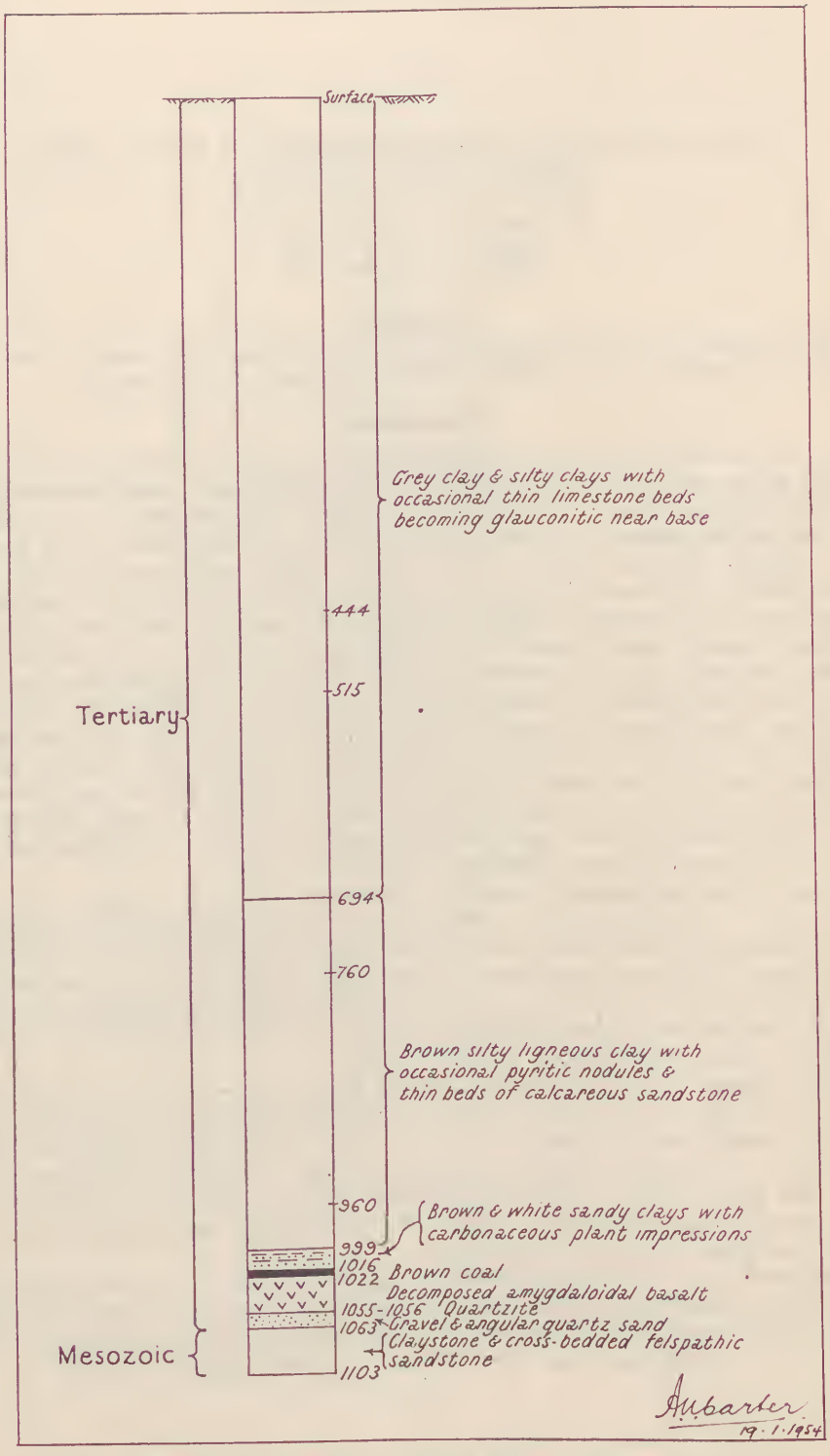

FIG. 1.—Lithological sequence in Victorian Mines Department Bore No. 1 at Birregurra, Victoria.

Microspore Content

(1) *Dark grey clays at 444-515 feet.*

Two samples were analysed, one at 444-449 feet, the other at 511-516 feet, but the pollen and spore content is too low to give an adequate idea of the flora of the period. Pollen grains of two types of *Nothofagus* (*N.* sp. *a.* and *N.* sp. *e.*, cf. Cookson, 1946) and *Triorites harrisii* Couper were observed.

The presence of foraminifera and examples of the Hystrichosphaerideae indicates an environment in which the waters were saline.

(2) *Brown ligneous clays and silts between 760-960 feet.*

Most of the information regarding the microflora preserved in this section of the core has been obtained from samples 760-761 feet and 842-843 feet, in both of which the microspore content is high and varied. The majority of the pollen grains present are small dicotyledonous types, many of which have still to be classified. Of the recognizable forms, pollen grains of *Nothofagus* spp. and *Triorites harrisii* are most frequent, with the former predominating. Several coniferous types have been observed, usually, however, in low frequencies. The following sporomorphs occur:

Bryophyta—*Sphagnites australis* f. *parva* Cookson, *S. australis* f. *crassa* Cookson.

Pteridophyta—*Gleichenia circinidites* Cookson.

Coniferae—*Araucariacites australis* Cookson, *Dacrycarpites australiensis* Cookson and Pike, *Dacrydiumites florinii* Cookson and Pike, *Microcachryidites antarcticus* Cookson, *Trisaccites microperus* Cookson and Pike.

Dicotyledoneae—*Anacolosidites luteoides* Cookson and Pike, *Anacolosidites acutulus* Cookson and Pike, *Beaupreaidites verrucosus* Cookson, *Cupanieidites orthoteichus* Cookson and Pike, *Cupanieidites majus* Cookson and Pike, *Cupanieidites reticularis* Cookson and Pike, *Myrtaceidites eugeniioides* Cookson and Pike, *Nothofagus* spp. a, c, d, e Cookson, *Proteacidites annularis* Cookson, *Proteacidites crassus* Cookson, *Proteacidites grandis* Cookson, *Proteacidites pachypolus* Cookson and Pike, *Santalumidites cainozoicus* Cookson and Pike, *Tricolpites thomasii* Cookson and Pike, *Triorites harrisii* Couper, *Triorites magnificus* Cookson.

The occurrence of Hystrichosphaerids and Dinoflagellates indicates a continuance of the saltwater environment of the higher levels.

(3) *Brown coal situated between 1006 and 1022 feet.*

The microspore content at this level is numerically lower and less varied than that of the preceding series, and many of the sporomorphs found at the higher levels are absent. Those recognized are: *Gleichenia circinidites, Dacrydiumites florinii, Dacrydiumites mawsonii, Trisaccites microperus, Nothofagus* spp. and *Triorites edwardsii* Cookson and Pike. Small three-aperturate types with triangular ambs are relatively abundant.

No examples of marine groups such as the Hystrichosphaerideae have been observed.

(4) *Pale grey mudstone at 1089-1092 feet.*

The microflora preserved at this level may be taken as representative of the deposits intersected at the bottom of the Birregurra bore. It consists mainly of

trilete Pteridophyte spores and some two- and three-winged pollen grains referable to the Podocarpaceae. No dicotyledonous types have been recognized. The only forms that at present can be classified in greater detail are the sporomorphs *Microcachryidites antarcticus* and *Mohriosporites australiensis* Cookson.

Vertical Distribution of Sporomorphs

Some of the sporomorphs isolated from the Birregurra core are known, from their occurrences elsewhere in Australia, to have extended from Eocene or earlier to Pliocene. Such long-range forms, which include *Sphagnites australis* f. *parva*

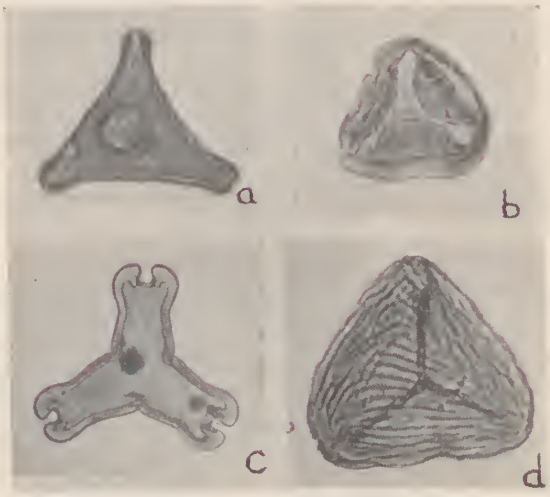

Fig. 2.—Sporomorphs characterizing the three microfloras in the Birregurra bore. a, *Proteacidites pachypolus*; b, *Trisaccites microplerus*; c, *Triorites edwardsii*; d, *Mohriosparites australiensis*.

(Cretaceous to Pliocene), *Gleichenia circinidites* (Cretaceouse to Pliocene), *Araucariacites australis* (Cretaceous to Pliocene), *Dacrycarpites australiensis* (Eocene to Pliocene), *Nothofagus* sp. *a* (Eocene to Quaternary) and *Triorites harrisii* (Eocene to Pliocene), have little stratigraphical value and are mainly of geographical and palaeo-ecological interest.

Other types, for example *Dacrydiumites mawsonii, Microcachryidites antarcticus* and some of the *Nothofagus* pollen types, have less clearly known limits either because of uncertainties regarding age of the deposits in which they have been found (especially lignitic freshwater series) or doubts concerning the identity and vertical distribution of the sporomorphs themselves.

However, four of the sporomorphs occurring in the Birregurra deposits, evidently with limited time-ranges, appear likely to prove useful stratigraphical indicators in the Upper Mesozoic-Lower Tertiary succession. They are: (1) *Mohriosporites australiensis,* (2) *Trisaccites microplerus,* (3) *Proteacidites, pachypolus,* (4) *Triorites edwardsii.*

(1) *Mohriosporites australiensis.*

This is a characteristic type morphologically similar to spores of the fern *Mohria*, an African member of the family Schizaeaceae. It also agrees closely with the fossil *Mohriosporites dorogensis* R. Pot. and Gell. which ranges in Europe from Lower Cretaceous (Wealden) to Oligocene (Thiergart, 1949).

Mohriosporites australiensis is one of the most abundant types in the pre-basaltic section of the Birregurra bore and is especially abundant at 1089-1090 feet. It has been recorded from Mesozoic mudstones situated between 651-708 feet in the Comaum (South Australia) bore (Cookson, 1953) and has been observed in a Lower Cretaceous marine shale from Onepah Station, north of Tibooburra in north-western New South Wales, and in the Styx River series of Queensland. So far *M. australiensis* has not been found in Jurassic deposits. Dr. N. J. de Jersey has kindly permitted me to report its absence from the Jurassic coals of the Rosewood coal fields, Queensland, upon which he is working; it also appears to be absent from the Jurassic coals at Wonthaggi, Victoria.

M. australiensis has not been observed in the post-basaltic portions of the Birregurra core nor in any of the Australian Tertiary deposits hitherto examined. It therefore appears that *M. australiensis* is restricted to the Cretaceous.

(2) *Triasscites micropterus.*

This is readily distinguished from other three-winged coniferous pollen grains by its frequently triangular outline in polar view and the much reduced broadly attached bladders. It has a wide geographical distribution in Australia and ranges from the Jurassic to the Older Tertiary (Cookson and Pike, 1954).

Although the upper limit of *T. micropterus* cannot be specified, most of the Tertiary deposits in which it occurs and for which indications of age are available are regarded by geologists as being low in the sequence. This applies to the Anglesea Siltstone Member of ?Middle Eocene age, according to Raggatt and Crespin (1952); the Eastern View Coal Measures (Paleocene to Eocene, according to Raggatt and Crespin, 1952); the Wensleydale brown coal; the beds between 842 and 1020 feet in the Birregurra bore; lignite at 106-110 feet in a bore at Bambra; the Pebble Point Formation (Paleocene to Lower Eocene, Baker, 1943, 1953; Singleton, 1943; and Teichert, 1943), and the ligneous horizon between 515 and 538 feet in the Cootabarlow bore, thought to be Upper Cretaceous by Whittle and Chebotarev (1952). So far *T. micropterus* has not been observed in the pre-basaltic section of the Birregurra core, although it extends into the Mesozoic sediments at Comaum, South Australia, and is a component of the microflora of the Lower Cretaceous Styx and Burrum Coal Measures.

(3) *Proteacidites pachypolus.*

This is a characteristic sporomorph of uncertain affinity, infrequent occurrence (Cookson and Pike, 1954), and probable Eocene age. Evidence in support of such an age is provided by its occurrence in the Anglesea Siltstone, the sandy clay with *Cyclammina* at the base of the Castle Cove section, Aire Coast, Victoria, the suggested age for which is Upper Eocene or older (*vide* Dr. O. P. Singleton), and the Cootabarlow lignites, which are probably not younger than Eocene. The only beds in which it has been found that may be younger are the deep leads at Vegetable Creek, New South Wales, the age of which remains uncertain. It has not been observed in the brown coals at Bacchus Marsh and the Latrobe Valley.

The restricted distribution of *P. pachypolus* in the Birregurra bore is in keeping with the suggested Eocene age.

(4) *Triorites edwardsii.*

This is a rare type which, so far, has only been found in deposits situated in south-western Victoria and south-eastern South Australia. These are the Eastern View Coal Measures; the Benwerrin brown coal; Lal Lal, near Ballarat, in Mines Department Bore 51 at 398 feet, and in Bore 47 at 206-223 feet; the Pebble Point Formation; the Nelson bore at 3723, 3874, 4025 feet, all in Victoria; and the coal in the Comaum bore, South Australia, at 619 feet 6 inches.

All these deposits are low down in the Tertiary sequence and could be of Lower Eocene or even Paleocene age on the basis of Raggatt and Crespin's correlation of the Eastern View Coal Measures (1952, p. 146). This position and probable age is supported by the apparent restriction of *Triorites edwardsii* to the base of the post-basaltic section of the Birregurra bore, i.e. from 1006-1020 feet.

Relationships of Microfloras

Considerably more information regarding the identity and distribution of the microspore types in Australian Mesozoic and Older Tertiary deposits is necessary before full comparisons between the microfloras of these strata can be made. Nevertheless tentative conclusions regarding the relationship of some of the deposits in the Upper Mesozoic and Older Tertiary sequences can now be drawn from a comparison of microfloras in described strata of known age with those of the Birregurra succession.

It has been found that three distinct microfloras occur in the Birregurra bore and that each contains one distinctive sporomorph that seems characteristic of the sediments in which it occurs. For the present, these microfloras will be designated A, B and C.

Microflora A, occurring between 1073 and 1090 feet

This microflora is characterized by the absence of dicotyledonous pollen grains and the presence of *Mohriosporites australiensis* which, elsewhere in Australia, appears to be restricted to Cretaceous deposits. It is probable, therefore, that the sediments in this section of the Birregurra bore are also Cretaceous. For similar reasons the same age is indicated for the deposits between 651 and 708 feet in the Comaum bore, South Australia.

Mr. P. R. Kenley (personal communication) has drawn attention to the resemblance between the sediments in the Birregurra bore containing Microflora A and the Runnymede Formation in the Glenelg district in far south-western Victoria. The Runnymede Formation which lies between Jurassic and Lower Eocene or Paleocene sediments is regarded as Cretaceous (Kenley, 1954).

Microflora B, occurring between 1006 and 1020 feet

Microflora B is characterized by the incoming of coniferous types not present in Microflora A, and a limited number of dicotyledonous pollen types of uncertain affinities including *Triorites edwardsii.* This sporomorph is also known from the Eastern View Coal Measures; the Benwerrin coal; in bores at Lal Lal, at 398 and 206 to 223 feet; the Pebble Point Formation and the Nelson Bore at 3723 and 4025 feet. On the basis of the occurrence of *T. edwardsii* it is considered that the horizons mentioned contain Microflora B, and that they are all approximately of the same age, that is, Paleocene to early Eocene.

TABLE 1.—*The distribution of some of the sporomorphs in Older Tertiary deposits in South-western Victoria*

Name of Sporomorph	Microflora C.					Microflora B.			
	Birregurra Bore 760–960 feet	Anglesea Siltstone Formation	Basal Beds Castle Cove Aire Coast	Princetown Member	Clay parting in Wensleydale brown coal	Birregurra Bore 1006–1020 feet	Pebble Point Formation	Eastern View Coal Measures	Caol at Benwerrin
Araucariacites australis ..	+	+	+	+	+	+	+	+	+
Dacrycarpites australiensis ..	+	+	–	+	+	–	–	+	–
Dacrydiumites florinii ..	+	+	+	+	+	+	+	+	+
Dacrydiumites mawsonii ..	+	+	+	+	+	+	+	+	+
Microcachryidites antarcticus .	+	+	+	+	+	+	+	+	+
Trisaccites microplerus ..	+	+	+	+	+	+	+	+	+
Anacolosidites acutulus ..	+	–	+	–	+	–	–	–	–
Anacolosidites luteoides ..	+	+	+	+	–	–	–	–	–
Beaupreaidites verrucosus ..	+	+	+	+	+	–	–	–	–
Cupanieidites orthoteichus ..	+	+	+	+	+	–	–	–	+
Cupanieidites majus	+	+	–	–	–	–	–	–	–
Myrtaceidites eugeniioides ..	+	+	+	+	+	–	–	–	–
Nothofagus sp. *c*	+	+	–	+	+	–	–	–	–
Nothofagus sp. *d*	+	+	+	–	–	–	–	–	–
Nothofagus spp.	+	+	+	+	+	+	+	+	+
Proteacidites annularis ..	+	+	+	+	+	–	–	–	–
Proteacidites crassus	+	+	+	+	+	–	+	–	+
Proteacidites grandis	+	+	+	+	+	–	+	–	+
Proteacidites incurvartus ..	+	+	–	+	+	–	–	–	+
Proteacidites pachypolus ..	+	+	+	–	–	–	–	–	–
Santalumidites cainozoicus ..	+	+	+	–	–	–	–	–	–
Tricolpites thomasii	+	+	+	–	–	–	–	–	–
Triorites edwardsii	–	–	–	–	–	+	+	+	+
Triorites harrisii	+	+	+	+	+	+	–	–	–
Gleichenia circinidites (Fern) .	+	+	+	+	+	+	+	+	+
Sphagnites australis forma *parva* (Moss)	+	+	+	+	+	+	+	+	+

Microflora C, occurring between 760 and 960 feet

In Microflora C there is a marked increase in the number of dicotyledonous pollen types and such components as *Anacolosidites luteoides, Cupanieidites orthoteichus, Myrtacieidites eugeniioides* and *Santalumidites cainozoicus* can be closely compared with pollen of living species. *Triorites edwardsii* is no longer present. The index fossil chosen to characterize Microflora C is *Proteacidites pachypolus.*

It is considered that Microflora C is also present in the Anglesea Siltstone, the basal bed in the Castle Cove section, the Princetown Member of the Dilwyn Clay, the Nelson Bore at 992 feet and possibly the Wensleydale coal seam and associated clay (Table 1).

From geological considerations it is suggested that Microflora C is, in part at least, Eocene, although later in the Eocene than Microflora B. At present no indications can be given for its upper limits.

Comparison of the Birregurra (760-960 feet) with other Microfloras

Anglesea

The components of these two microfloras are closely similar, even such rare examples as *Anacolosidites luteoides, Cupanieidites majus, Santalumidites cainozoicus* and *Tricolpites thomasii* being common to both. Moreover, each has a high and varied microspore content which includes *Proteacidites pachypolus* and *Trisaccites microperus.* There is thus a strong indication that the two deposits belong to the same horizon.

Basal Clays of the Castle Cove Section

The sporomorph *Proteacidites pachypolus* selected as characterizing this portion of the Birregurra core is occasionally found in the microspore assemblage in the Castle Cove clay. The affinity between these deposits is further supported by the occurrence of *Trisaccites microperus* and examples of *Anacolosidites acutulus, Anacolosidites luteoides, Santalumidites cainozoicus* and *Tricolpites thomasii.*

Wensleydale

This correlation is not quite so exact as the previous ones owing to the apparent absence from the Wensleydale coal and clay parting of the sporomorphs *Proteacidites pachypolus, Anacolosidites luteoides, Santalumidites cainozoicus* and *Tricolpites thomasii.* The most characteristic and conspicuous type in the Wensleydale deposits in *Proteacidites grandis.* This form has been observed also, although less frequently, in residues of the sediments at Birregurra (760-960 feet), Anglesea, Castle Cove, and of the Princetown Member. *Trisaccites microperus, Anacolosidites acutulus* and *Beaupreaidites verrucosus* are three sporomorphs of apparently limited vertical range common to Wensleydale and Birregurra.

Princetown Member of the Dilwyn Clay

The microspore content of the Princetown Member is neither so high nor so varied as that of the other deposits mentioned. As far as can be judged at present it differs from the assemblage at Birregurra principally in the absence of *Proteacidites pachypolus, Santalumidites cainozoicus* and *Tricolpites thomasii.*

Stratigraphical Significance

Independent evidence is available for the succession of the microfloras described from the Birregurra bore. In the Nelson bore Microflora B is present at 3723 and 4025 feet, and C occurs at 992 feet. In the Moonlight Head-Princetown sequence, B occurs in the basal Pebble Point Formation and C in the overlying Dilwyn clay and the Princetown member of this formation. In the Eastern View-Anglesea sequence, B characterizes the Eastern View Coal Measures and C the overlying Anglesea Siltstone. There is little doubt, therefore, that the three microfloras are distinct and of stratigraphical significance. This being so, they provide a basis, even if an inexact one, for correlation of some of the Cretaceous and older Tertiary deposits of western Victoria and contiguous parts of South Australia.

The only correlation, instanced above, that is at variance with geological observations is that between the Wensleydale coal seam and the marine Anglesea Siltstone and beds of similar lithology between 760 and 960 feet in the Birregurra bore. As stated above, the microflora at Wensleydale differs somewhat from other microfloras referred to C, so that even on palynological grounds there is reason for doubting the reliability of this association. It has already been shown that the microflora of the Wensleydale coal has much in common with the Comaum coal at 619 feet 6 inches (*loc. cit.*) which on account of the association of *T. edwardsii* with pollen grains of definite myrtaceous and proteaceous affinities appears to be intermediate in character between Microfloras B and C.

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References

Baker, G., 1943. Eocene Deposits South-east of Princetown, Victoria. *Proc. Roy. Soc. Vic.*, 55: 237-254.

———, 1950. Geology and Physiography of the Moonlight Head District, Victoria. *Proc. Roy. Soc. Vic.*, 60: 17-43.

———, 1953. The Relationship of *Cyclammina*-bearing sediments to the Older Tertiary deposits south-east of Princetown, Victoria. *Mem. Nat. Mus. Melb.*, 18: 125-134.

Cookson, Isabel C., 1946. Pollens of *Nothofagus* Blume from Tertiary deposits in Australia. *Proc. Linn. Soc. N.S.W.*, 71: 49-63.

———, 1953. Difference in Microspore Composition of some Samples from a Bore at Comaum, South Australia. *Aust. J. Bot.*, 1: 462-473.

Cookson, Isabel C., and Pike, Kathleen M., 1954. Some dicotyledonous pollen types from Cainozoic deposits in the Australian region. *Aust. J. Bot.*, 2: 197-219.

Couper, R. A., 1953. Upper Mesozoic and Cainozoic Spores and Pollen Grains from New Zealand. *N.Z. Geol. Surv., Palaeontological Bull.*, 22: 1-77.

de Jersey, N. J., 1951. Microspore correlation, Burrum Coalfield. *Qld. Govt. Min. J.*, 52: 781-788.

Kenley, P. R., 1954. The Occurrence of Cretaceous Sediments in South-western Victoria. *Proc. Roy. Soc. Vic.*, 66: 1-16.

RAGGATT, H. G., and CRESPIN, Irene, 1952. Geology of Tertiary Rocks between Torquay and Eastern View, Victoria. *Aust. J. Sci.*, 14: 143-147.

SINGLETON, F. A., 1943. An Eocene Molluscan Fauna from Victoria. *Proc. Roy. Soc. Vic.*, 55: 266-281.

SUGGATE, R. P., and COUPER, R. A., 1952. The Stratigraphic Relations and Plant Microfossils of New Zealand Coal Measures. *N.Z. J. Sci. Tech. B.*, 34: 106-117.

TEICHERT, C., 1943. Eocene Nautiloids from Victoria. *Proc. Roy. Soc. Vic.*, 55: 259-265.

THIERGART, F., 1949. Der stratigraphische Wert mesozoischer Pollen und Sporen. *Palaeontographica* B, 89: 1.

WHITTLE, A. W. G., and CHEBOTAREV, Nina, 1952. Stratigraphic correlations by petrographic methods applied to Artesian Bores in the Lake Frome Area. *Sir Douglas Mawson Anniversary Volume* (Univ. of Adelaide): 185-202.

WALKOM, A. B., 1919. Mesozoic Floras of Queensland—Parts III and IV. The Floras of the Burrum and Styx River Series. *Pub. Geol. Surv. Qld.*, 263: 1-76.